

## CLAIMS

1. A method of producing sub-critical water decomposition products, comprising:

5           continuously supplying material to be processed into a reactor through an inlet provided for the reactor, whose interior is kept at a sub-critical condition for water,; and  
              continuously taking out a liquid containing a decomposition product through one or a plurality of outlets provided at a different position from the position where the inlet of the reactor is provided, to adjust residence time of the liquid containing the  
10 decomposition product in the reactor.

2. A method of producing sub-critical water decomposition products, comprising:

continuously supplying material to be processed into a reactor through an inlet  
15 provided for the reactor, whose interior is kept at a sub-critical condition for water,;  
              continuously taking out a liquid containing a decomposition product through one or a plurality of outlets provided at a different position from the position where the inlet of the reactor is provided, to form desired steady concentration profiles the decomposition product in the reactor; and

20           taking out the desired decomposition product through, among the one or plurality of outlets, one or more outlet(s) provided at a position where the concentration of the desired decomposition product is high.

3. A method of producing sub-critical water decomposition products,  
25 comprising:

continuously supplying material to be processed that contains solid matter having a slow decomposition rate with sub-critical water and a different specific gravity from that of the sub-critical water, into a vertical-type reactor whose interior is kept at sub-critical conditions for water, through an inlet provided for the reactor;

- 5       adjusting, with one or a plurality of outlets provided at a position different in height from where the inlet is provided for the reactor, an outlet position from which a liquid containing a decomposition product is let out and an outlet amount thereof, to make a steady flow in the sub-critical water in a steady state, the steady flow flowing in an opposite direction to the direction in which the solid matter sinks or floats up and  
10      being slower than the sinking velocity or floating velocity of the solid matter;

- forming in the steady flow, in the following order from the upstream of the flow, at least a fluidized bed in which the solid matter is decomposed into fine particles by the sub-critical water and the fine particles fluidize in the flow, and a sub-critical water dissolution part in which the material to be processed is turned into further finer particles  
15      or completely turned into a soluble material to flow with the sub-critical water;

      further forming, depending on the type of the material to be processed, a fixed bed in which solid matter stays in a fixed location even with the flow, the fixed bed formed upstream of the fluidized bed; and

- taking out the liquid containing a desired decomposition product from the  
20      sub-critical water dissolution part from the reactor, using one(s) of the one or plurality of outlets.

4. A method of producing sub-critical water decomposition products, comprising:

- 25      causing a mixture of material to be processed containing a solid matter and

sub-critical water to flow in sub-critical water in a steady state in an opposite direction to the direction in which the solid matter flows;

forming in the flow, in the following order from the upstream of the flow, at least a fluidized bed in which the solid matter is decomposed into fine particles by the  
5 sub-critical water and the fine particles fluidize in the flow, and a sub-critical water dissolution part in which the material to be processed is turned into further finer particles or completely turned into a soluble material to flow with the sub-critical water;

further forming, depending on the type of the material to be processed, a fixed bed in which solid matter stays in a fixed location even with the flow, the fixed bed  
10 formed upstream of the fluidized bed; and

adjusting the distance through which the sub-critical water dissolution part flows to vary the residence time of the solid matter and the residence time of the sub-critical water from each other and to adjust the degree of decomposition of the components of the material to be processed that have been made soluble to the sub-critical water, whereby a  
15 target decomposition treatment product is obtained.

5. The method according to claim 4, wherein the solid matter sinks in the mixture being in a steady state, and the flow of the mixture is in an opposite direction to the gravitational force.

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6. The method according to claim 4, wherein the solid matter floats about in the mixture in a steady state, and the flow of the mixture is in a direction of the gravitational force.

25 7. The method according to any one of claims 4 through 6, wherein, in the

mixture in a steady state, the flow rate of the mixture is less than the sinking velocity or the floating velocity of the mixture.

8. The method according to any one of claims 4 through 7, wherein the mixture  
5 is slurry.

9. The method according to any one of claims 1 through 7, wherein the reaction  
temperature of the sub-critical water decomposition is within a range of from 130°C to  
374°C, and the reaction pressure is in a range equal to or higher than the saturated water  
10 vapor pressure at the reaction temperature.

10. The method according to any one of claims 1 through 8, wherein the material  
to be processed is at least one material selected from food, livestock products,  
agricultural products, marine products, wood, natural organic matter, plastics, chlorinated  
15 organic compounds, rubber, fiber, and wastes thereof, as well as sewage treatment wastes  
and wastewater treatment wastes.

11. An apparatus for sub-critical water decomposition treatment, comprising:  
a reactor configured to decompose material to be processed using sub-critical  
20 water;

heating means for heating a mixture composed of water and the to be processed  
material to form and keep sub-critical conditions for water; and compressing means for  
compressing the mixture;

introducing means for introducing the material to be processed into the reactor;  
25 an inlet for introducing the material to be processed to the reactor;

an outlet for letting out a mixture of a decomposition product and water from the reactor, characterized in that:

the outlet is provided at a position or positions different from the position where the inlet is provided, so that the outlet can take up a plurality of positions.

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12. An apparatus for sub-critical water decomposition treatment comprising:

a vertical-type reactor configured to decompose material to be processed with sub-critical water;

heating means for heating a mixture of water and the material to be processed  
10 and compressing means for compressing the mixture, to form and keep a sub-critical condition for water;

introducing means for introducing the material to be processed into the reactor;  
an inlet for introducing the material to be processed into the reactor; and  
an outlet for letting out a mixture of water and a decomposition product from the  
15 reactor, characterized in that:

the reactor is arranged substantially vertically;

the inlet is provided for at least one of a top end portion or a bottom end portion of the reactor; and

the introduced mixture of the material to be processed and the sub-critical water  
20 is caused to flow, in the sub-critical water in a steady state, in an opposite direction to the direction in which the solid matter travels, so as to form in the flow, in the following order from the upstream of the flow, at least a fluidized bed in which the solid matter is decomposed into fine particles with the sub-critical water and the fine particles fluidize in the flow, and a sub-critical water dissolution part in which the material to be processed is  
25 turned into further finer particles or completely into a soluble material to flow with the

sub-critical water, and to further form, depending on the material to be processed, a fixed bed in which solid matter stays in a fixed position even with the flow, the fixed bed being formed upstream of the fluidized bed, and the position of the outlet is adjustable so as to let out the sub-critical water dissolution part and adjust the distance through which the  
5 sub-critical water dissolution part flows.

13. The apparatus for sub-critical water decomposition treatment according to claim 12, wherein the outlet is formed at a plurality of positions on a sidewall of the reactor along the flow direction.

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14. The apparatus for sub-critical water decomposition treatment according to claim 12, wherein the outlet is. [sic.]

15. The apparatus for sub-critical water decomposition treatment according to  
15 any one of claims 12 through 14, characterized in that the vertical-type reactor is provided with monitoring means through which the interior is visualized.

16. The apparatus for sub-critical water decomposition treatment according to any one of claims 12 through 15, characterized in that: the vertical-type reactor is a  
20 cylindrical vessel; the inlet is circular; and the inner diameter of the inlet is within a range of from 1/5 times to 1/15 times the inner diameter of the vertical-type cylindrical vessel.

17. The apparatus for sub-critical water decomposition treatment according to any one of claims 12 through 16, characterized in that the apparatus comprises a plurality  
25 of the vertical-type reactors.

18. The apparatus for sub-critical water decomposition treatment according to any one of claims 12 through 17, characterized in that:

the apparatus further comprises a tubular reactor for secondary reaction joined to  
5 the outlet of the reactor; and

the inner diameter of the tubular reactor for secondary reaction is within a range  
of 1 to 1/5 times the inner diameter of the vertical-type cylindrical tubular vessel.

19. The apparatus for sub-critical water decomposition treatment according to  
10 any one of claims 12 through 18, characterized in that:

a plurality of the tubular reactors for secondary reaction are provided; and  
the tubular reactors for secondary reaction are connected in series and/or parallel  
with one another.

15 20. The apparatus for sub-critical water decomposition treatment according to  
claim 18 or 19, characterized in that the apparatus further comprises heating and cooling  
means for controlling the reaction temperature in the tubular reactor for secondary  
reaction.

20 21. The apparatus for sub-critical water decomposition treatment according to  
any one of claims 12 through 20, characterized in that:

the vertical-type reactor is provided with a back-pressure valve; and  
the reaction pressure in the vertical-type reactor is controlled using the  
back-pressure valve.

22. The apparatus for sub-critical water decomposition treatment according to claim 21, characterized in that a cooling pipe is provided immediately before the back-pressure valve.